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THE EPA-ORD MOBILE INCINERATION SYSTEM TRIAL BURN

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16. ABSTRACT

This paper discusses testing of the EPA Mobile Incineration system developed through the Office of Research and Development for the purpose of destroying hazardous materials on site. The test program (Trial Burn) consisted of a series of five tests that were designed to evaluate the system's ability to destroy selected hazardous organic materials and to control emissions of HCl , particulate matter, and organics in accordance with the requirements of the TSCA, RCRA, and the New Jersey State Department of Environmental Protection. Discussed herein are: (1) the trial burn plan including the sampling and analytical program, (2) the results of the tests, and (3) the impact of the test program on the local environment.

The function of the Mobile Incineration System is to demonstrate the ability of on-site thermal destruction of hazardous materials at remote spill or disposal sites. Since treatment of hazardous materials is controlled by state and federal regulations, a Trial Burn Plan was developed to comply with these regulations and establish the performance capability of the system in destroying/detoxifying hazardous and toxic substances.

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ABSTRACT

This paper discusses the initial trial burn testing of the EPA Mobile Incineration System developed through the Office of Research and Development for the purpose of destroying hazardous materials on site. The trial burn program consisted of a series of five tests that were designed to evaluate the system's ability to destroy selected hazardous organic materials and to control emissions of HCl, particulate matter, and organics in accordance with the requirements of the TSCA, RCRA, and the New Jersey State Department of Environmental Protection. Discussed herein are: (1) the trial burn plan including the sampling and analytical program, (2) the results of the tests, and (3) the impact of the test program on the local environment.

INTRODUCTION

The EPA's Office of Research and Development sponsored the development of a mobile incineration system through its Oil and Hazardous Materials Spills Branch located in Edison, New Jersey. The system was designed, constructed and tested under contracts with MB Associates, Mason & Hanger-Silas Mason Company and IT Enviroscience.

The function of the Mobile Incineration System is to demonstrate the ability of on-site thermal destruction of hazardous materials at remote spill or disposal sites. Since treatment of hazardous materials is controlled by state and federal regulations, a Trial Burn Plan was developed to comply with these regulations and establish the performance capability of the system in destroying/detoxifying hazardous and toxic substances. The plan incorporated a series of five trial burn tests that were conducted in three phases from September 1982 through January 1983 at the EPA facility in Edison, New Jersey. The tests evaluated the ability of the Mobile Incineration System to destroy carbon tetrachloride, di-, tri-, and tetrachlorobenzenes, and PCBs while controlling the emissions of HCl and particulate matter. This was accomplished by conducting a total of 25 test runs while monitoring the incinerator's operating conditions and conducting an extensive sampling and analytical program to measure gaseous, liquid, and solid emissions. All test runs were monitored, on site, by state and federal observers, to ensure that the incineration system was operated safely and in accordance with trial burn permits.

TRIAL BURN PLAN

The ability of the mobile incineration system to reach and maintain operating conditions was initially demonstrated during two shakedown tests using clean diesel fuel as simulated waste feed. However, a series of trial burn tests were necessary to demonstrate the ability of the mobile incinerator to destroy hazardous materials.

The trial burn tests were designed to: (1) verify the design of the incinerator subsystems (particulate and HCl removal and organic destruction); (2) supply trial burn data required for the Toxic Substances Control Act (TSCA), Resource Conservation and Recovery Act (RCRA), and New Jersey Department of Environmental Protection (NJDEP) permits; and (3) demonstrate total system operation including ancillary equipment (waste feed, flue gas monitors, utilities, etc.).

As shown in Table 1, these three test objectives were accomplished in a three phase trial burn program that consisted of five tests; each test conducted with a different feed material. The feed mixtures and the purpose of the tests are shown in Table 1.

Phase I consisted of Test 1 which provided baseline operating and performance data. Phase II consisted of Tests 2 and 3 and was designed to measure particulate removal efficiency of the air pollution control (APC) equipment, the HCl removal efficiency of the APC, and the destruction and removal efficiencies (DRE) for carbon tetrachloride and o-dichlorobenzene. Phase III consisted of Tests 4 and 5 during which two different concentrations of Askarel, a PCB/trichlorobenzene mixture, were fed to measure the DRE for those compounds, as well as to measure particulate and HCl removal efficiencies. All organic DRE tests and particulate removal tests required triplicate "Runs" -- three runs per test -- in accordance with federal and state regulations. The complexity of the sampling equipment required for the DRE test and the limited work area for collecting stack samples prevented the simultaneous collection of particulate emission data that would satisfy NJDEP requirements. Therefore, an additional three runs had to be conducted for each test to collect particulate data for compliance with NJDEP regulations.

TABLE 1. TRIAL BURN TEST SUMMARY

Test No.	Phase No.	Feed Material	Number of Runs	Test Purpose
1	1	diesel fuel	2 DRE[a] 2 Particulate	baseline performance
2	2	1.2% Fe_2O_3 [b] 98.8% diesel fuel	3 Particulate	particulate removal efficiency of APC
3	2	21.4% CCl_4 [c] 28.9% $C_6H_4Cl_2$ [d] 49.7% diesel fuel	3 DRE 3 Particulate	destruction of RCRA organic; HCl removal efficiency of APC
4	3	11.4% Askarel[e] 88.6% diesel fuel	3 DRE 3 Particulate	destruction of PCB (TSCA); HCl removal efficiency of APC
5	3	39.3% Askarel[e] 60.7% diesel fuel	3 DRE 3 Particulate	destruction of PCB; HCl removal efficiency of APC

a - destruction and removal efficiency of principal organics
b - iron oxide
c - carbon tetrachloride or tetrachloromethane
d - ortho-dichlorobenzene or 1,2-dichlorobenzene
e - 58.9% Aroclor 1260, 35.0% trichlorobenzenes, 6.1% tetrachlorobenzenes

NOTE: All compositions are reported on a wt/wt basis.

SYSTEM DESCRIPTION

The Mobile Incineration System has been described in detail by Yezzi et al[1] and accordingly will only be described here in general terms. The total system can be subdivided into three major subsystems: (1) combustion and air pollution control (APC) equipment mounted on three trailers, (2) continuous monitoring equipment located in a fourth trailer, and (3) ancillary support equipment. Figure 1, illustrates the layout of the incineration system in an open bay of a building at the GSA Raritan Depot in Edison, NJ during Phase III of the trial burn.

COMBUSTION AND AIR POLLUTION CONTROL EQUIPMENT

The Mobile Incineration System process design is demonstrated by a block flow diagram, Figure 2. Briefly, the incineration process consists of a primary combustion chamber (rotary kiln) where solid or liquid wastes are introduced and heated to approximately 980° C (1800°F) and a secondary combustion chamber (SCC) where the vaporized, partially combusted wastes are heated to approximately to 1200°C (2200°F) and retained for sufficient time (2 seconds) to achieve complete combustion of all organics. The incineration equipment is followed by a gas cleaning process designed to collect and remove particulate matter and acid gases from the combustion flue gases prior to discharge from the stack. The initial cleaning of the combustion gases is accomplished by water quenching in the quench elbow which is followed by particulate matter removal on a wetted fiberglass filter in a cleanable high efficiency air filter (CHEAF). The final step in the gas cleaning process is the removal of acid gases in a cross flow packed bed mass transfer scrubber. The pH of all process water streams is controlled by the addition of sodium carbonate to enhance acid gas removal and to mimimize corrosion of the gas cleaning equipment. The prime gas mover for the incineration system is a diesel powered induced draft fan which maintains a negative pressure in the entire process so as to prevent the leakage of toxic vapors. The process gas is discharged through a 12 m (40 ft) stack.

CONTINUOUS MONITORING SYSTEM

Combustion efficiency and stack emissions are monitored through the utilization of a fourth trailer that contains continuous monitors that measure the concentration of O_2, CO_2, CO, total hydrocarbons (THC), SO_2, and NO_x in the SCC and in the stack. The gas monitoring system is described in detail by Brugger et al[2]. Briefly, the system collects samples from the incineration process at two locations (the secondary combustion chamber and the stack) and directs the gaseous samples to two gas chromatographs and a chemiluminescent detector for analysis. The complete analysis of each sample is accomplished in five minutes and results are printed out on a computer terminal. Data from the monitoring system are used to determine the combustion efficiency by measuring the ratio of partially oxidized gas components (CO and total hydrocarbons) to the completely oxidized gas component, CO_2. The stack emissions from the incineration system are also monitored for SO_2 and NO_x to ensure compliance with air quality standards.

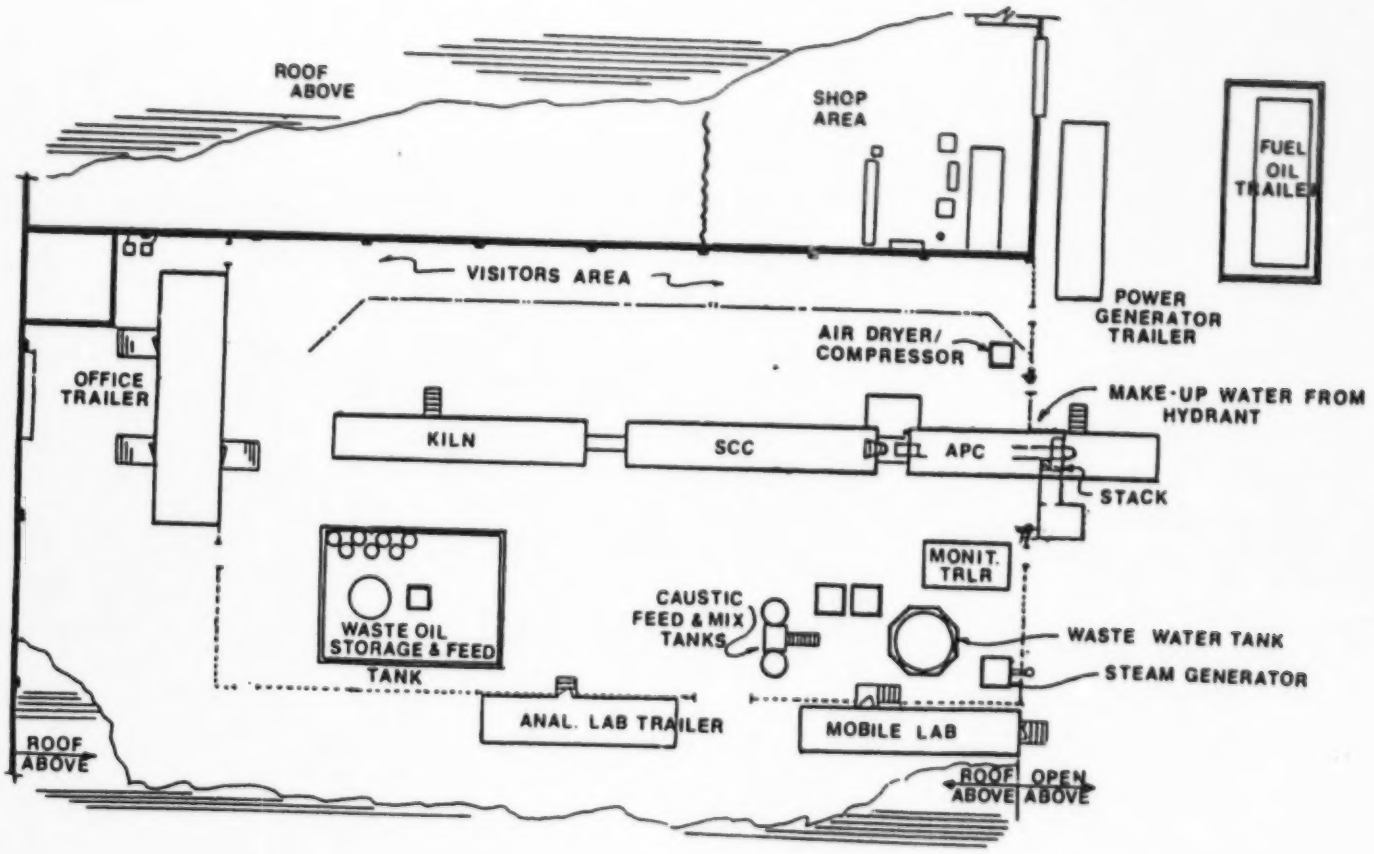

Figure I. Site Layout for Phase III of Trial Burn

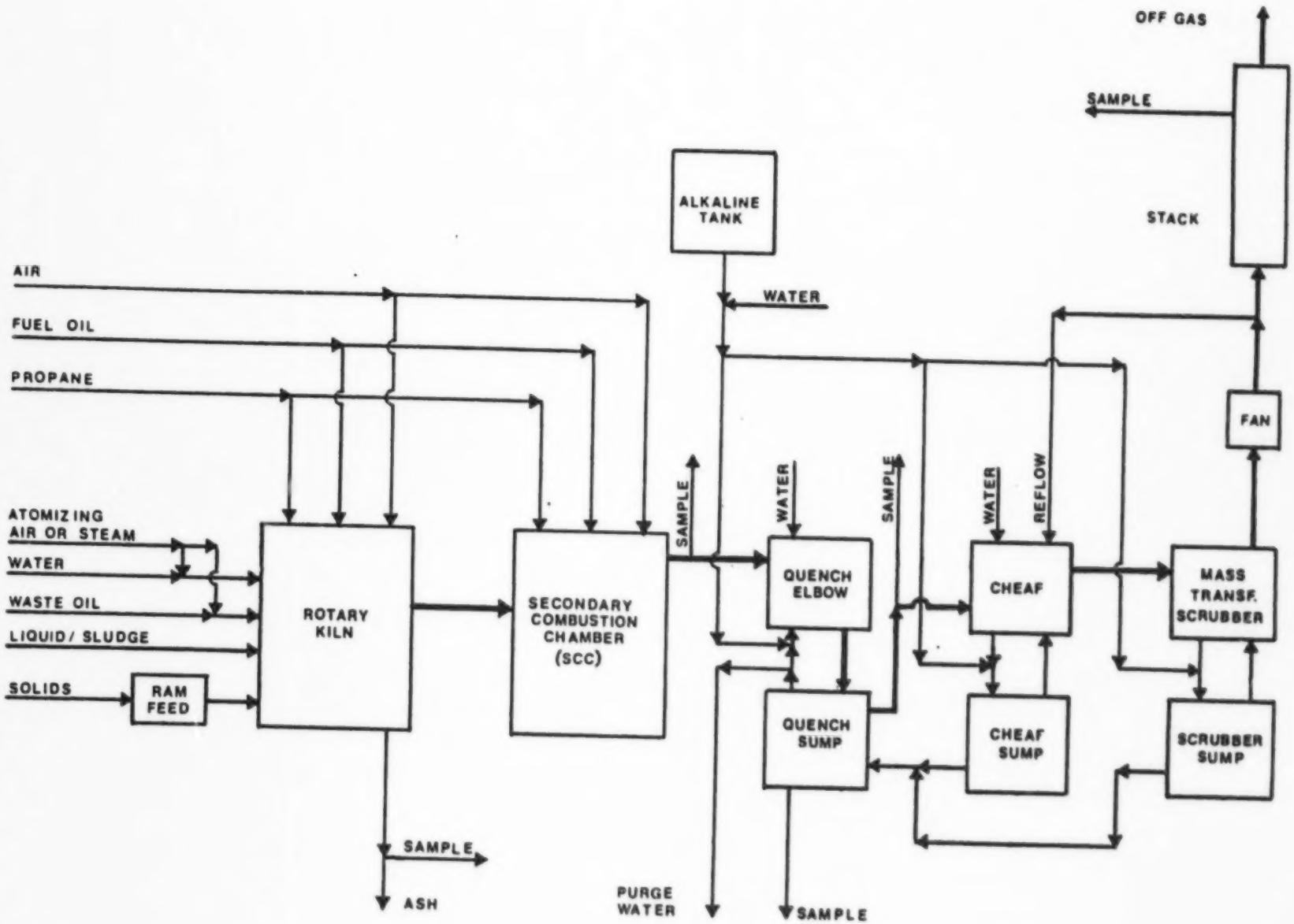

Figure 2. BLOCK FLOW DIAGRAM OF MOBILE INCINERATION SYSTEM

ANCILLARY SUPPORT EQUIPMENT

Since the mobile incineration system was designed to operate at remote sites ancillary support equipment was used during the Trial Burn to generate process utilities (power, steam, and compressed air) and provide tankage for the preparation and feed of waste liquids and alkaline scrubbing solution (Figure 1). Consequently, the Trial Burn was sucessfully conducted under conditions similar to field operations that would require utilities, feed and storage tanks, analytical support and personnel facilities.

All electrical power required to illuminate the work area and operate the incineration system, personnel facilities, and mobile analytical laboratory was provided by two diesel-powered generators. Steam used for atomization of the water injected into the rotary kiln and operation of the sample eductors on the continuous monitoring system was provided by a small, diesel-fired boiler. Compressed air for atomization of the waste oil injection into the rotary kiln and for various instrument requirements was provided by a diesel powered air compressor. Diesel fuel required to power the utility generators and provide auxiliary fuel for the incineration system was stored in a diked, 11,355 L (3000 gal) tanker which was refilled by a local fuel oil supplier on a regular basis.

Simulated waste oil mixtures for the tests were prepared by mixing specified quantities of the test compounds and diesel fuel in a sealed, agitated vessel prior to each test run. The mixture was then pumped through a mass flow meter directly into the rotary kiln . The waste feed system was designed and operated as a closed system to minimize the exposure of operating personnel to hazardous materials. The waste feed area was diked to permit the storage of test materials in the drums in which they were received.

Alkaline feed solution, used to neutralize acid gases in the air pollution control equipment, was prepared in twin, agitated tanks by mixing sodium carbonate (50 lb bags) with water to form a 6% solution. Process water from the incineration system was pumped into a holding tank for sampling and for measuring pH and temperature prior to discharge into a storm sewer.

Sampling and analytical crews used two mobile laboratories, one for the preparation and disassembly of stack gas sampling equipment, and the other for on-site analysis of ambient air samples and the initial preparation of test samples for analysis. Operating personnel used a trailer for a lunchroom and for holding safety meetings conducted at the beginning of each shift.

Safety equipment, including temperature controlled eye baths and safety showers, fire extinguishers, first aid equipment, and an evacuation alarm system, was placed at strategic locations around the test site. Spill control equipment such as foam dike packs, shovels, sorbent and spill clean-up blankets was available in the event of an oil or hazardous material spill. Personal protection equipment for routine operation and for special situations (handling of the hazardous and toxic test materials) was available and utilized during the trial burn.

SAMPLING LOCATIONS AND METHODS

A critical aspect of any test program is the selection of sampling locations and the methods used to provide accurate data on the operating conditions and performance of the equipment being tested. The sampling program designed for the mobile incinerator trial burn had to: (1) meet the needs of regulatory agencies that monitored the system's compliance with state and federal statutes and (2) provide operating engineering data for the continued development and demonstration of mobile incineration technology. These needs were met by sampling all feed and discharge streams (solid, liquid, or gaseous) during test runs. The methods used to sample the various process streams ranged from simply filling a sample bottle with make-up water from the fire hydrant source, to the operation of a Modified Method 5 sampling train capable of collecting micrograms of PCBs and other organics. Each sampling location and method is briefly described below and summarized in Table 2.

WASTE FEED

Test mixtures were prepared in a 3785 L (1000 gal) tank before each test. Prior to the test, the feed material was mixed by the tank agitator and by circulating the feed mixture with the transfer/decontamination pump back to the tank. When a feed sample was collected during a test, a sampling loop was activated on the feed line to the transfer pump feeding the incineration system (see Figure 3). After filling the sample loop, the flow was directed back to its normal flow pattern. Three-way valves on the sampling system were switched to release the feed sample into the sample bottle. This procedure was designed to permit collecting a representative sample while minimizing the potential for spillage or exposure to toxic materials by operating personnel. Samples were collected at the beginning, middle, and end of each test run and composited to generate representative samples for analysis.

MAKE-UP WATER AND ALKALINE FEED SOLUTION

Make-up water for the quenching of hot combustion gases was potable water obtained directly from a fire hydrant. Samples of water were collected during each phase of testing for baseline analysis of the test materials and other organics.

A solution of sodium carbonate and make-up water was prepared on a regular basis for neutralization of acid gases adsorbed in the APC equipment. Each batch, approximately 600 gallons, was sampled using a solvent rinsed dipper and composited to generate a single sample for each test.

KILN ASH

Kiln ash samples were removed from the ash discharge chute on the rotary kiln. Since the wastes fed during the trial burn consisted of clean, ash-free liquids, the quantity of kiln ash collected was small, consisting primarily of attrition from the kiln refractory. At the end of each run, the ash chute was emptied into a stainless steel pan which had been rinsed with hexane. Ash samples were then transferred into sample jars and sent to the laboratory for analysis.

TABLE 2. SAMPLING AND ANALYTICAL PROGRAM FOR TRIAL BURN

SAMPLE	SAMPLING METHOD AND FREQUENCY	ANALYSIS
Waste Feed	One Composite Sample Per Run (3 Grabs)	Elemental (C, H, O, N. S, Organic Cl), Density, Heavy Metals (As, Be, Cd, Cr, Cu, Hg, Pb, Se, Zn), POHCs[a]
	One Sample per Test	PCDD[b], PCDF[c]
Diesel Fuel	One Grab Sample per delivery, Composite Sample for one analysis per lot	Elemental (C, H, O, N, S, Organic P & Cl) Density, Ash, Moisture
Make-up Water	One Sample per Test Phase	Presence of POHCs Presence of PICs[d]
Kiln Ash	One Sample per DRE[e] Test	Presence of POHCs Presence of PICs, PCDD, PCDF
Purge Water	One Composite Sample per DRE run One Sample per Test	Presence of POHCs Presence of PICs PCDD, PCDF
	Daily Composite Weekly Grabs	Total Organic Carbon, pH, temperature Petroleum Hydrocarbons Total Suspended Solids Volatile Organics Total Dissolved Solids
	Weekly Composite	POHCs
Akaline Scrubber Solution	One Grab Sample per Batch Composite Grab sample	POHCs, PICs
CHEAF Ash	One Sample per DRE Run	Presence of POHCs, PICs, PCDD, PCDF
Stack Sample	Modified Method 5; One Sample per DRE Run (Three Samples per Test)	POHC Emission Rate HCl Emission Rate PIC Identification and Estimated Concentration PCDD Emission Rate PCDF Emission Rate
	New Jersey Incineration Method; Three Samples/Test	Particulate Emission Rate
	Sampling of Quench Elbow Duct; Three Samples per Test	Particulate Emission rate (Test 2 only)
	Gas Bag, One per Run	O_2, CO_2
	VOST; RCl Sample	RCl Emission Rate
	Visual Inspection Four 6 min. observation per DRE Run, One 30 min. observation per Particulate Run	Opacity (Tests 1,2, and 3)
Site Monitoring	One Set of Samples per DRE Test	PCBs
Personnel Monitoring	One Set of Samples per DRE Test (6 locations)	PCBs, TCB

a - POHC = Principal Hazardous Organic Component (test compounds)
b - PCDD = Polychlorinated Dibenzo-p-dioxin
c - PCDF = Polychlorinated Dibenzofuran
d - PIC = Product of Incomplete Combustion
e - DRE = Destruction and Removal Efficiency

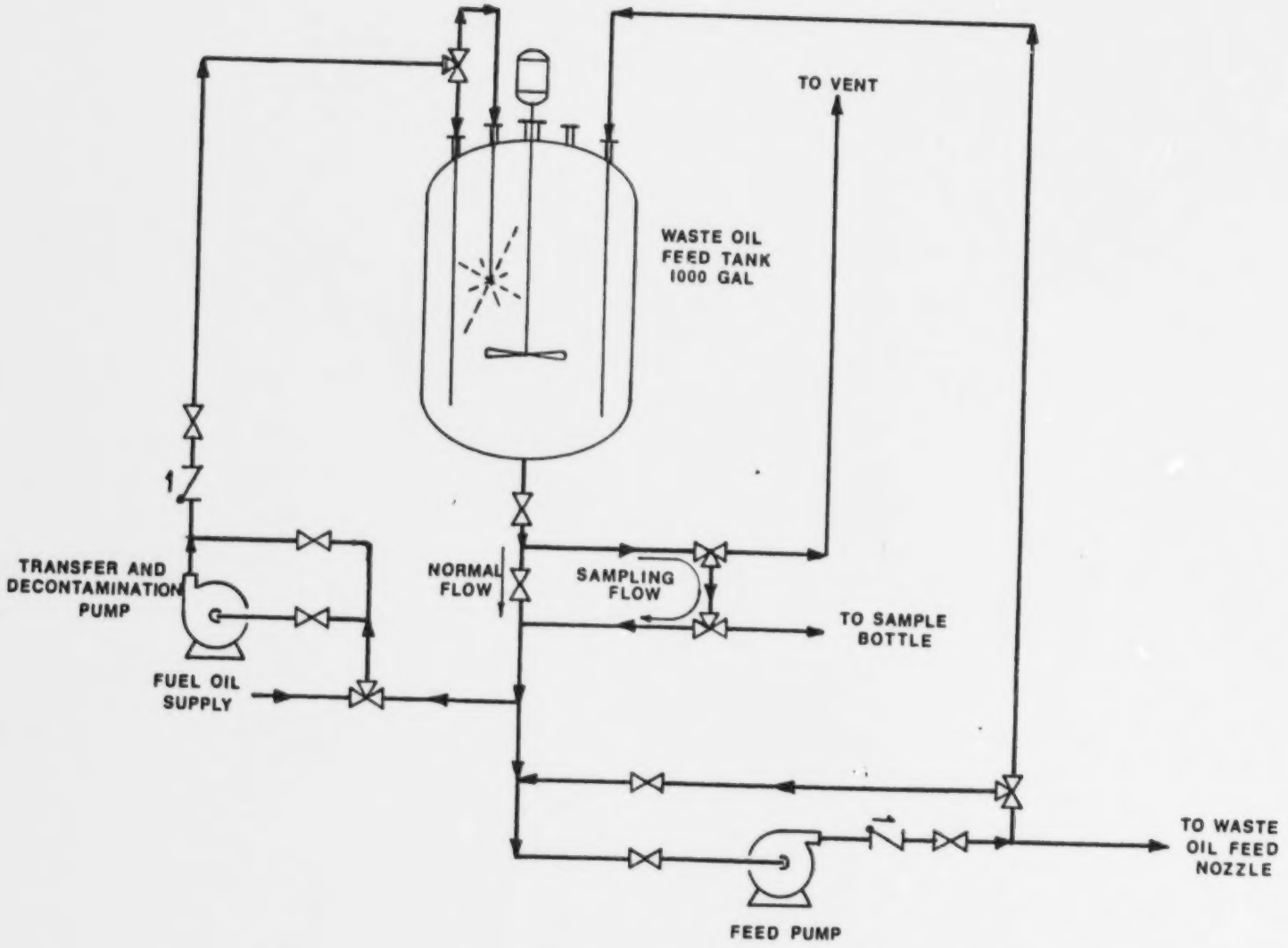

Figure 3. FLOW DIAGRAM OF FEED TANK AND FEED SAMPLE LOCATION

CLEANABLE HIGH EFFICIENCY AIR FILTER (CHEAF) MEDIUM

Samples of the CHEAF fiberglass filter medium that had been exposed to the incinerator flue gas were collected after each test run. The filter medium was rolled and weighed on spring scales to determine the total sample weight. A representative sample was then removed from the folded filter media using a coring tool made of 2-in. aluminum pipe. The core sample was extracted for analysis of organics.

PURGE WATER

During the trial burn tests, the aqueous effluent from the CHEAF and mass transfer (MX) scrubber sumps was forwarded to the quench sump to be used as recycle quench water. A portion of this recycle water was purged from the quench sump to control the build-up of suspended and dissolved solids in the APC equipment. This purge stream, the combined aqueous waste from the quench, CHEAF, and MX scrubber, was pumped to a wastewater tank. Hourly purge water samples were collected by opening the gate valve on the purge water tank and allowing the purge water to flow into a 1-L glass container. Approximately 500 mL of water was collected and discarded before the actual sample was collected. After completion of the test run, all grab samples were composited to form the purge water sample.

STACK GAS

The samples for gas composition, organic test compounds, hydrogen chloride, particulate matter, and chlorinated organics were all collectd in the stack in accordance with the requirements of 40 CFR Part 60 Appendix A Reference Methods. The stack is 2 ft (61 cm) square (2 ft equivalent stack diameter) at the sampling location. Five sampling ports are located 10 ft (3 m) downstream (5.0 stack diameters) of the silencer outlet and 6.4 ft (2 m) upstream (3.2 stack diameters) of a restriction before the stack exit. At this location EPA Method 1 - "Sample and Velocity Traverses For Stationary Sources" requires that 30 traverse points be used for the extraction of a representative sample. Six (6) traverse points were sampled in each of the five sampling ports. The velocity profile at the stack test locations was determined in accordance with guidelines outlined in EPA Method 2 - "Determination of Stack Gas Velocity and Volumetric Flow Rate". The gas velocity and volumetric flow rate were determined from velocity, pressure, and gas temperature data collected during each test run. Stack gas composition was determined on an integrated sample in accordance with procedures outlined in EPA Method 3 - "Gas Analysis for Carbon Dioxide, Oxygen, Excess Air and Dry Molecular Weight". Sampling for volatile organics, including chlorinated organics (RCIs), was conducted using a volatile organic sampling train (VOST). Sampling for other organics was accomplished with a Modified Method 5 (MM5) sampling train shown in Figure 4 which contained two sorbent resin traps, Florisil and XAD-2, and an extra empty impinger. Organics in the stack gas were collected on sorbent resins in both the VOST and MM5 trains and then removed from the resins in the laboratory for analysis.

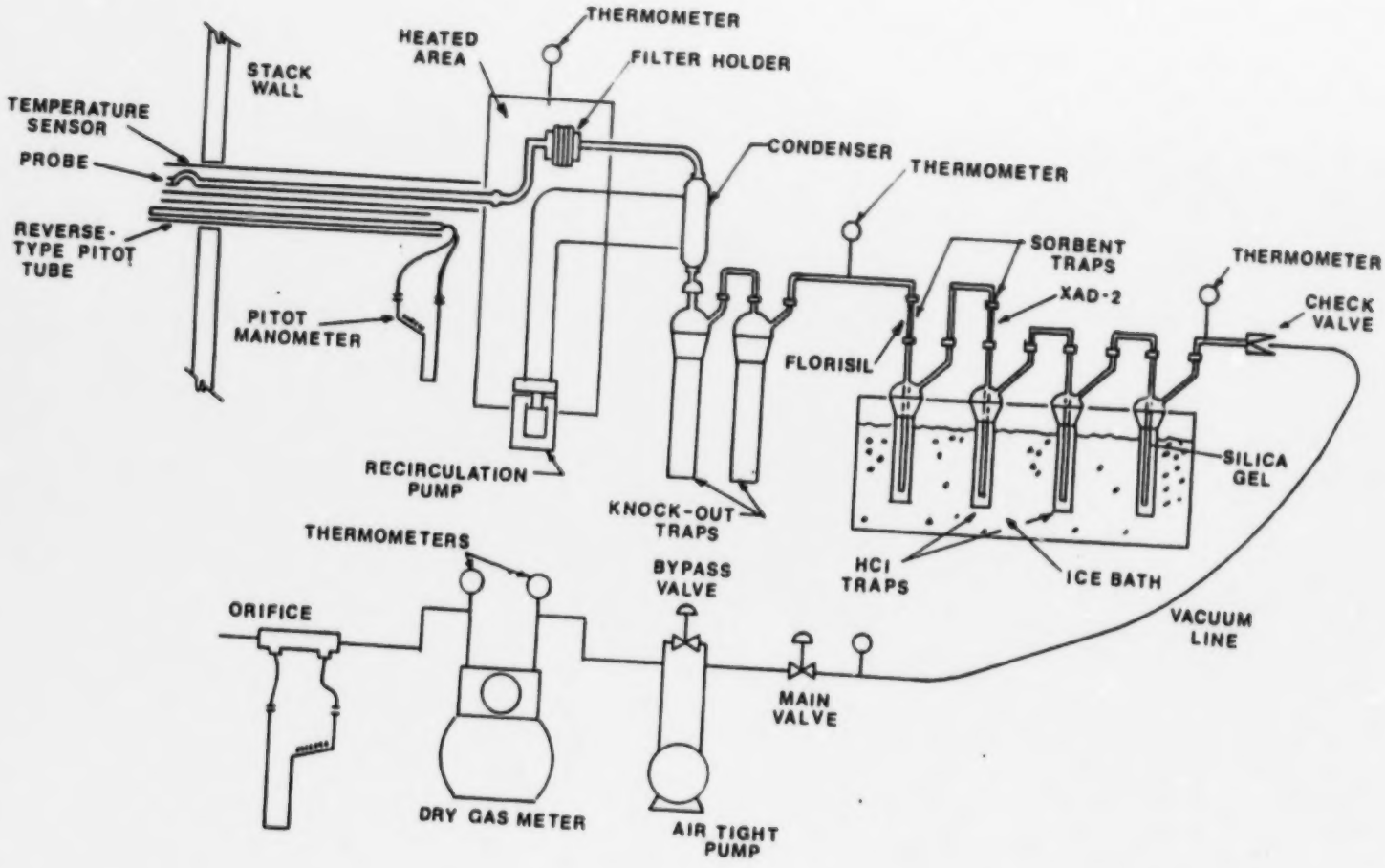

Figure 4. MODIFIED METHOD 5 SAMPLING TRAIN

SITE AND PERSONNEL MONITORING

An extensive air sampling program was conducted during the third phase of the testing program in order to monitor the ambient air in the immediate vicinity of the mobile incinerator and to determine the impact of the stack emissions on the surrounding area. The ambient air was analyzed for tri- and tetrachlorobenzenes (TCB) and PCB's (the test feed components) to determine the exposure level, if any, of operating personnel and the local community. Previously run air dispersion models by the EPA, based on assumed stack organic emissions, indicated that actual organic emissions would not exceed allowable short term exposure levels and would be at least 2500 times less than allowable annual exposure levels.

The fugitive emissions from the incinerator and waste handling equipment were determined using six sampling stations located near the incinerator. Ambient air samples were continuously taken during 8 hr shifts to measure the levels of PCB to which incinerator operators were exposed. Each station included two battery operated sampling systems affixed to ring stands and placed at work stations rather than being worn by the workers. This procedure allowed workers to move about freely and provided continuous sampling of the workplace environment.

Personnel monitoring stations were located as shown in Figure 5. Station #1 was located near a safety shower approximately 15 ft (4.6 m) away from the secondary combustion chamber. The sample tube was approximately 6-1/2 ft (2.0 m) above floor level. Station #2 was located between the PCB mixing tank and the rotary kiln. The sampling tube was approximately 4 ft (1.2 m) above floor level. Station #3 was initially located 12 ft (3.7 m) away from the incinerator about 4 ft (1.2 m) above floor level, but on January 12 and 13, 1983, the station was moved onto the rotary kiln trailer and the sampling tubes were placed near the entrance end of the rotary kiln. Station #4 was located approximately 4 ft (1.2 m) away from the MX Scrubber at a height of 8 ft (2.4 m). Station #5 was located on the stack sampling platform at a height of 5-1/2 ft (1.7 m). Station #6 was located at the exit end of the rotary kiln.

Similar monitoring stations were set up away from the incineration system (Figure 6) to determine the impact of the emissions downwind of the system. A portable weather station and daily weather reports were used to determine wind direction so that sampling stations could be placed in the path $\pm 45^{o}$ of the incinerator plume. The stations were moved as needed to collect a downwind sample for 8 hours. An upwind sample was also collected to determine the background level of TCB and PCB.

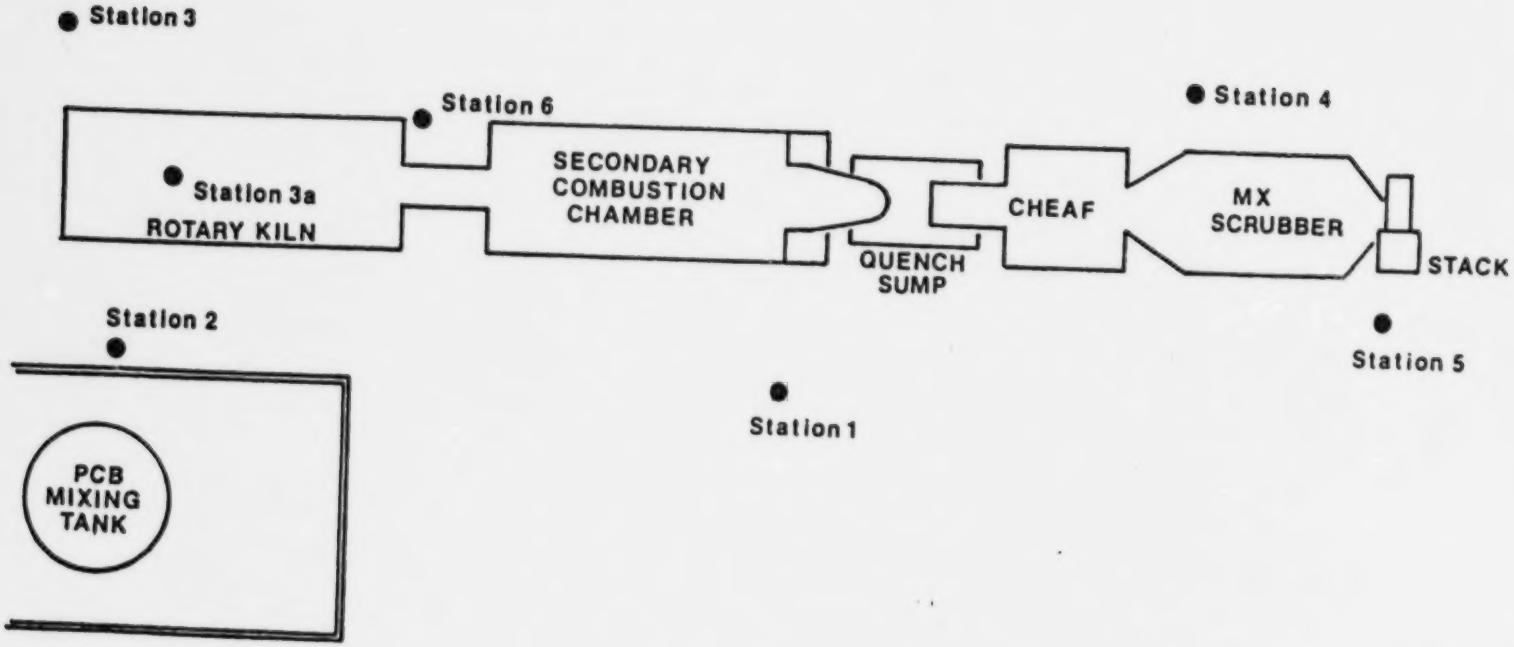

Figure 5. LOCATION OF PERSONNEL MONITORING STATIONS

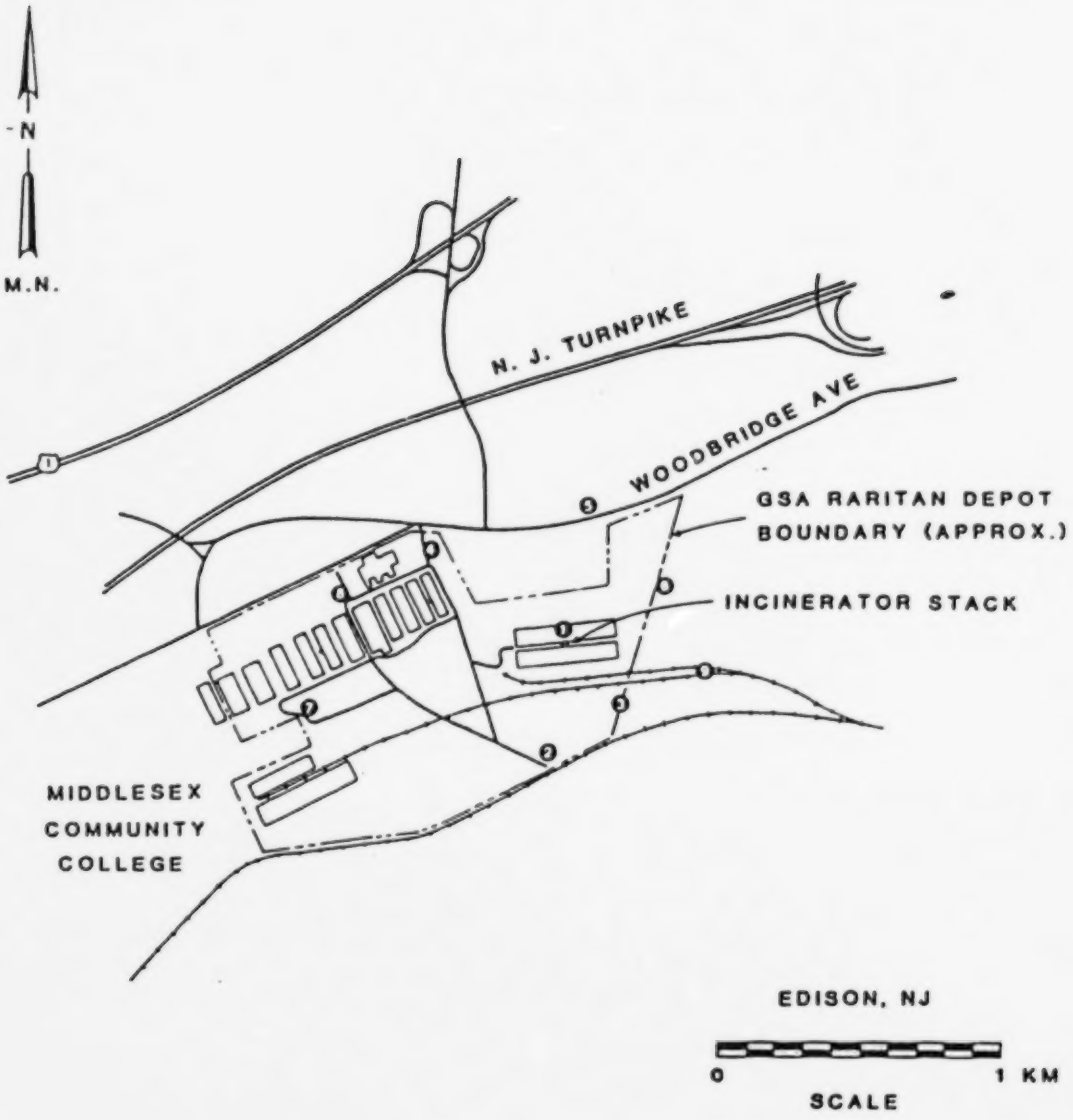

Figure 6. SITE MONITORING LOCATIONS

TRIAL BURN RESULTS

The test results from the trial burn can be readily understood by evaluating five principal performance criteria: (1) particulate matter removal efficiency, (2) HCl removal efficiency, (3) organic destruction efficiency, (4) waste water quality, and (5) ambient air quality. The first three criteria define the major emissions from the stack of the mobile incineration system. These three criteria, in addition to waste water quality, are closely monitored to ensure compliance with state and federal regulations. The fifth criterion, ambient air quality, is important from a socio-political point of view that is very important to the citizens in the local community. Data on each of these performance criteria will be presented separately to provide an organized view of the test results.

Particulate Removal Efficiency

The removal of particulate matter from the combustion chamber flue gas is accomplished in the APC equipment. Particulate matter comes from solids or ash, and from heavy metals that could be present in liquid wastes burned in the rotary kiln. Since materials burned during the trial burn were clean liquids, free of heavy metals or significant quantities of ash, a test mixture of iron oxide powder and diesel fuel was prepared for measuring the particulate removal efficiency of the APC equipment. Iron oxide was chosen because of its availability in the specific particle size range needed for the test, 0.4-0.9 micron. The concentration of iron oxide in test mixtures ranged from 0.8 to 1.6 weight percent. The results of the three test runs are presented in Table 3. Interpretation of the results reveals that the particulate removal efficiency of the APC section exceeded 90% for all test runs. The primary objective for the test was to determine whether the particulate emission rate was below the level set by the regulations (180 mg/dscm according to RCRA.) As shown in Table 3 the particulate emission rate, corrected to 7% O_2 in the stack, was well below the allowable emission rate.

Particulate emission rates were measured for the other test mixtures even though the mixtures were composed of "clean" components. The emission rates for the other test runs ranged from 6.3 to 80.2 mg/dscm (corrected to 7% O_2), well below the allowable emission rate.

HCl Removal Efficiency

The control of acid gases, primarily HCl from the combustion of chlorinated organics, is regulated by RCRA. Test 3 of the trial burn used a test mixture rich in organochlorine compounds in order to measure the ability of the APC equipment to remove high levels of HCl from the combustion gases. During Tests 4 and 5, when PCBs were fed to the incinerator, the potential to produce significant quantities of HCl also dictated the measurement of HCl removal efficiency.

The results of these tests, presented in Table 4, indicate that the regulatory criteria were met during all trial burn test runs. RCRA restricts HCl emissions to 4 lbs/hr or 99% removal, whichever is greater.

TABLE 3. SUMMARY OF PARTICULATE REMOVAL RESULTS, TEST 2

TEST NUMBER DATE	2E 10/21/82	2G 10/22/82	2I 10/23/83
WASTE FEED			
Fe_2O_3 (lb/hr)	1.66	2.60	3.31
STACK			
Flowrate (dscfm)	4016	3940	4113
Fe_2O_3 (lb/hr)	0.145	0.100	0.157
Fe_2O_3 Removal Efficiency (%)	91.2	96.2	95.3
Particulate Emission* (mg/m^3)	23.7	25.8	16.7

* Corrected to 50% excess air (7% O_2) in accordance with RCRA.

TABLE 4. SUMMARY OF HCl REMOVAL RESULTS

TEST NUMBER	Test 3 Average	Test 4 Average	Test 5 Average
WASTE FEED			
HCl in feed* (lb/hr)	88.97	15.27	52.83
STACK			
HCl emission (lb/hr)	0.040	0.002	0.003
Removal efficiency (%)	99.96	99.98	99.99
HCl concentration (ppm)	1.6	0.13	0.18

*Based on chlorine content of test feed (refer to Table 1 for waste composition)

Organic Destruction Efficiency

The destruction of hazardous organic compounds is the major function of the mobile incineration system, and accordingly, the measurement and demonstration of the destruction and removal efficiency (DRE) was the major reason for conducting the Trial Burn. The compounds selected for the tests were those considered to be refractory (i.e. difficult to destroy) in incineration systems. These compounds were carbon tetrachloride, di-, tri-, and tetrachlorobenzenes, and PCBs. The DRE results for these compounds (Tests 3, 4, and 5) are shown in Table 5. The RCRA required DRE for carbon tetrachloride and chlorinated benzenes is 99.99%. This criterion was exceeded by 10 to 100 times during nine test runs. In addition, in all cases, the results shown in Table 5 are not limitations of the incinerator's ability to destroy hazardous organics but reflect the limitations of the ability to sample and analyze ultra-trace quantities of organics in the stack gas. Most of the stack samples (72 out of 93) did not contain enough material to identify and quantitate the test organics, so the quantities used to calculate DREs were levels of detection values and not necessarily actual emission values.

Another measure of the organic destruction rate is the combustion efficiency or ratio of the concentrations of carbon monoxide (CO) to carbon dioxide (CO_2), i.e.:

$$\text{Combustion efficiency} = 100\% \times [CO_2]/([CO_2] + [CO])$$

The required performance level of this criterion, according to TSCA, is 99.9%. The concentration of CO during the trial burn tests was so low, <1 ppm, that it was below the detection level of the two gas monitors (nondispersive infrared and gas chromatography) installed to measure it. The low CO concentration raised the combustion efficiency to over 99.999% or 100 times better than the required performance.

Waste Water Quality

The waste water from the incineration process was monitored for TOC, pH, temperature, total dissolved and suspended solids, petroleum hydrocarbons, and volatile organics, as well as for the presence of the test organic compounds. The results of hourly, daily, and weekly sampling and analysis of the waste water are summarized in Table 6. The concentration of the test organics in the waste water was lower than 20 µg/L (ppb) during the entire trial burn. The main contaminants in the waste water were dissolved salts from the neutralization of acid gases (HCl and SO_2) with scrubbing solution (sodium carbonate).

TABLE 5. SUMMARY OF ORGANIC DESTRUCTION RESULTS

TEST NUMBER		Test 3 Average	Test 4 Average	Test 5 Average
WASTE FEED				
CCl_4 [a]	(lb/hr)	70.1	--	--
DiClB[b]	"	94.9	--	--
TriClB[c]	"	--	8.43	33.2
TetraClB[d]	"	--	1.40	6.4
PCB[e]	"	--	14.6	50.0
STACK GAS				
CCl_4 [a]	(lb/hr)	$< 3.2 \times 10^{-5}$	--	--
DiClB[b]	"	$< 2.4 \times 10^{-5}$	--	--
TriClB[c]	"	--	$< 1.4 \times 10^{-5}$	$< 2.1 \times 10^{-5}$
TetraClB[d]	"	--	$< 8.8 \times 10^{-6}$	$< 8.8 \times 10^{-6}$
PCB[e]	"	--	$< 2.8 \times 10^{-5}$	$< 4.3 \times 10^{-5}$
DRE				
CCl_4 [a]	(%)	> 99.99995	--	--
DiClB[b]	"	> 99.99998	--	--
TriClB[c]	"	--	> 99.9998	> 99.99993
TetraClB[b]	"	--	> 99.9994	> 99.99985
PCB[e]	"	--	> 99.9998	> 99.99991

a - carbon tetrachloride
b - o-dichlorobenzene
c - trichlorobenzenes
d - tetrachlorobenzenes
e - polychlorinated biphenyls (Aroclor 1260)

TABLE 6. SUMMARY OF WASTE WATER ANALYSES

TEST WEEK	9/12/82	10/18/82	10/25/82	1/4/83	1/10/83
Average Daily Flow (gal/day)	4298	4962	5613	5613	9211
Average Total Organic Carbon (mg/L)	155	16	7	13	20
Temperature (^{o}C)	52-82	36-75	58-72	32-67	26-57
pH	7.5-10	6.5-11	7-9.5	8.5-9	7.5-8.5
Petroleum Hydrocarbons (mg/L)	< 1.0	< 1.0	< 1.0	2.6	1.5
Total Dissolved Solids (mg/L)	17,600	14,000	20,500	3360	12,900
Total Suspended Solids (mg/L)	338	65	68	55	36
Volatile Organics (µg/L)	86-99	133	< 10	--	< 10

Ambient Air Quality

The personnel and site monitoring programs consisted of air samples being collected in the immediate vicinity of the mobile incinerator and around the test site to measure the impact of the stack and fugitive emissions on the air quality. Data from personnel monitoring stations indicated low levels of tri- and tetrachlorobenzenes, 0.1 mg/m^3, near the waste feed tank and rotary kiln. No evidence of PCBs were found in any personnel monitoring samples. The concentration of chlorobenzenes is much lower than the level considered to be an industrial hygiene hazard.

The site monitoring program collected ambient air 0.3 to 1.0 km downwind from the incinerator stack detected no measurable quantities of chlorobenzenes or PCBs. The detection level for both tri- and tetrachlorobenzene was 0.1 ug/m^3 and for PCBs (as Aroclor 1260) was 1.0 ug/m^3. These data verify the conclusion of the EPA air dispersion modelling evaluation that the mobile incinerator does not adversely impact the quality of air in the local community.

SUMMARY

The Trial Burn was conducted to verify that the Mobile Incineration System could achieve compliance with federal and state (New Jersey) regulations governing the incineration of hazardous and toxic substances. During the Trial Burn tests the incineration system achieved over 99.99% destruction of synthetic wastes at feed rates of up to 70 lb/hr of carbon tetrachloride, 95 lb/hr of chlorinated benzene, and 50 lb/hr of PCB (as Aroclor 1260). The system's control and monitoring instrumentation was demonstrated to be capable of maintaining the required levels of performance.

The results of the Trial Burn confirmed that the air pollution control section of the Mobile Incineration System removed HCl (over 99%) and particulate matter (to less than 180 mg/m^3 corrected) in accordance with the requirement of state and federal regulations. An ambient air monitoring program, conducted during the Trial Burn, verified pre-Trial Burn EPA air modeling which indicated that the quality of the air in the local community would not be adversely affected by the incinerator emissions.

The results of the Trial Burn tests demonstrate that the Mobile Incineration System is capable of meeting and exceeding all applicable federal regulations. The large quantity of data collected and analyzed (over 10,000 pages of log sheets, chromatograms, calibrations, and results tables) clearly support the conclusion that the EPA Mobile Incineration System is a complete and efficient hazardous material destruction process.

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